Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

Vol. 36 No 12

BULLETIN

OF THE

TORREY BOTANICAL CLUB

DECEMBER, 1909

The plant formations of the Nockamixon Rocks, Pennsylvania

John W. Harshberger

After the Delaware River is joined by the Lehigh River, it flows almost due south, but in a sinuous course for a distance of ten miles to a point a mile below Riegelsville, then it flows southeastward a mile and five-eighths to Kintnersville. At this place, it makes a sharp bend and flows directly eastward to Milford on the New Jersey side, or Black's Eddy on the Pennsylvania side. The south bank of the river rises between Kintnersville and Narrowsville into a series of precipitous cliffs known as the Nockamixon Rocks (FIGURE 1). More accurately, if the east sheet of the topographic map of Bucks and Montgomery counties (No. 12, Pennsylvania Geological Survey, Final Report) is consulted, these cliffs are found to be situated between 75° 6′ and 75° 10′ west longitude and 40° 34′ north latitude. The boldest rocks frown down on three miles of the river's bank (FIGURE 2). According to the Pennsylvania survey, the crest of the cliffs is 500 feet above the river. The cliffs form a sheer wall of rock in many places (FIGURE 3), cut by ravines down which the streams tumble in cascades, or waterfalls. An expert mountain-climber might ascend the precipitous rocks, but a less expert climber must clamber the ledges of rock from cascade to cascade in the severa ravines that seam the rocks. As the streams that descend from above have an extremely limited watershed, they usually run dry during the summer months and little pools are left in the hollows of the water courses, where the wild birds are accustomed to drink.

[The BULLETIN for November, 1909 (36 : 615–650. *pl. 30–34*) was issued 16 N 1909.]

Rogers * fifty years ago described these cliffs as follows: "One stretch of precipice on the Pennsylvania side, known by the name of the Nockamixon Rocks is an exceedingly striking and picturesque range of beetling cliffs, rising sheer for 200 or 300 feet from the brink of the river with only a narrow roadway between them, through a length of nearly three miles. Some of the views from the base of these crags are almost grand; and the pictures they make with the river below are beautiful (FIGURE 2).

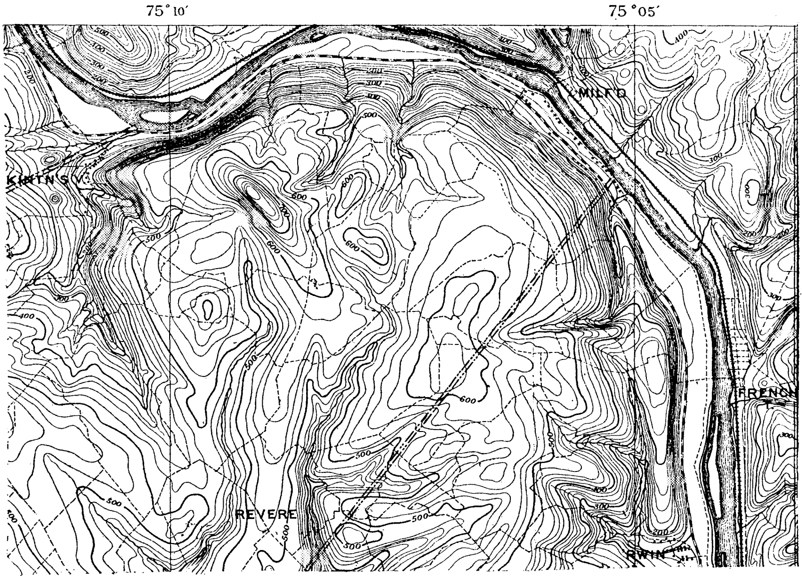

FIGURE 1. North part of Bucks County, Pennsylvania, north of Tohickon Creek, displaying the contour lines of the rock cliffs along the Delaware River, known as the Nockamixon Rocks. Between the 200-foot contour and canal lies the talus slope, between 200 feet and 400 feet, the precipices, while above 400 feet are the crest slopes Between Milford and Kintnersville lies the part surveyed botanically.

Tufts of bushes and trees and climbing vines heighten by their green hues the rich brown tints of the rocks, to the bold faces and narrow ledges of which they lend a grace which no cliffs without vegetation ever possess. There are few more attractive drives or walks by the river borders of Pennsylvania than the one at the foot of the Nockamixon Rocks." From the New Jersey side of

---

* Rogers, Henry D. The geology of Pennsylvania 1 : 48. 1858.

the river, these rocks suggest the well-known Palisades of the Hudson River, but their color and origin are different, as they are composed of red shale. From this distance, the cliffs seem to be unbroken and higher than actual measurement indicates. The vegetation from the opposite bank of the river appears confined to the talus and the upper more gradual slopes near the crest of the cliffs. A nearer approach confirms the distant view, but in addition the botanist notes that every ledge, shelf, and crevice is occupied by trees, shrubs, and herbaceous plants which grow either in the bare rocky soil or where a poor soil has been formed by the disintegration of the rock masses (FIGURE 4). Viewed from the towpath of the canal at the base of the cliffs, the impression is that of a mixed deciduous forest with clumps of hemlocks, here and there, or a facies of the red cedar (*Juniperus virginiana*) to break the more even crown of the broad-leaved forest trees. Back of the cliffs the forest has been cleared and the nearly level surface is devoted to the cultivation of the ordinary farm crops. Beyond the fields to the south rises a group of rounded hills, ranging from 600 to 780 feet, the highest point being three quarters of a mile south of the edge of the rocks. A canal and a dirt road occupy the shore between the lower edge of the talus and the river bank (FIGURE 2). The talus, which is considerable at the west end, but almost absent in the middle and at the east end, consists of extremely loose broken pieces of the shale rock. It is difficult to climb over such material, because it constantly slides from beneath the feet. The mass of rock is a hard red slate, but the edges of the rock-shelves break off only too easily, as the climber finds out in attempting to ascend from shelf to shelf by his hands and knees (FIGURES 4 and 5). Care must be exercised not to lay hold of a piece that breaks away from the cliff. Numerous cracks appear in the rocks following the natural cleavage-planes, so that the rock soil and talus material is extremely porous, permitting the rapid percolation of the rain-water, which, when it first falls, makes the soil and rocks extremely slimy and slippery. Such a substratum upon which the characteristic plants of the locality are found growing is noted for its physiologic dryness, which is especially noteworthy in the summer, when little rain falls, and yet it is surprising what a large number of plants will grow and carry on their life processes to fruition in such an excessively dry soil. There must be considerable water in the rocky strata beneath, because here and there in the ravines in the driest summer weather, water is seen oozing out where the water-bearing seams are exposed. Various hepatic mosses, true mosses, and several other plants remain green in such spots, while many other plants of the drier cliff-faces, having long since perfected their flowers and fruits, have dried up completely, all but their underground parts, which are reserved for perennation.

GEOLOGIC CHARACTER OF THE CLIFFS

The American New Red rocks extend across Bucks County into New Jersey. They are penetrated by eruptive dikes of trap rock which in our region form Haycock Mountain on the one hand and the celebrated Ringing Rocks on the other, while a crescent-shaped mass just back of the edge of the cliff at the time of its appearance probably altered the original color and texture of the surrounding Mesozoic red shales. In the center of the horseshoe shaped trap there is apparently a small trap hill on a higher

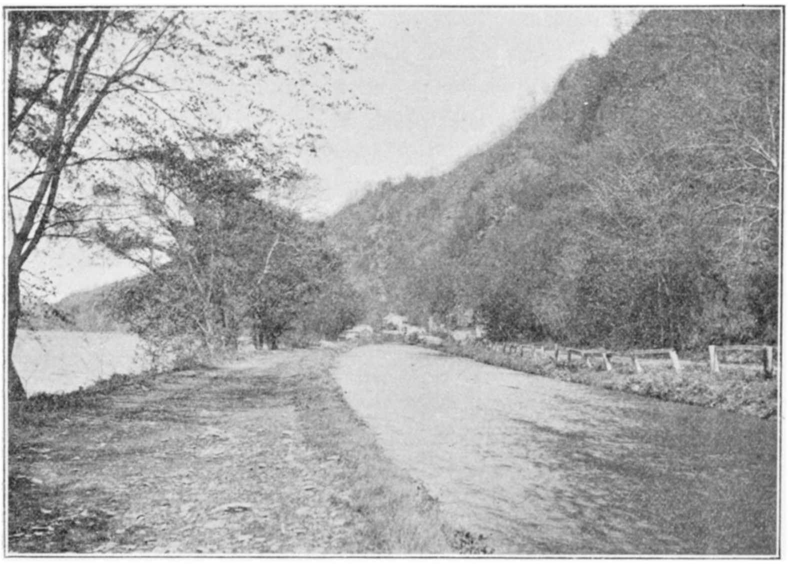

FIGURE 2. Nockamixon Rocks, Bucks County, Pa. General view of cliffs, canal, and Delaware River, looking east.

geologic horizon in the lower part of the Pottstown shales. The whole country hereabouts, elevated between 300 and 400 feet, is a table-land covered with trap rubbish and goes by the name of "the swamp" from the undrained condition of the soil, which is cold, wet, and unproductive. The whole series of New Red rocks comprises at least five subdivisions, beginning at the top, viz., the Pottstown; the Perkasie shales, 2000 feet thick; the Lansdale shales, 4700 feet; the Gwynedd shales, 3500 feet; and the Norristown shales, 6100 feet in thickness. The Nockamixon Rocks consist of shales of the second subdivision, viz., the Perkasie shales. These shales are comparatively hard, mostly green, dark red, or gray in color. Fossil traces of plants and animals occurring in these beds and mentioned by Professor Newberry, though few and imperfect, would seem to show that the shales are Jurassic.* The land underlaid by the Perkasie shales is generally less fertile than that of the neighboring red shales above (Pottstown) and below (Lansdale).

PLANT FORMATIONS OF THE CLIFFS.

The vegetation of the cliffs may be considered conveniently as it covers the talus slope, the precipitous rock faces, the sides of the ravines, and the crest of the escarpment. As the contour lines of the map will show, the upper part of the cliffs slopes away from the edge of the precipice until the crest is reached. The vegetation of the talus is a part of that characteristic of the Piedmont Region and it therefore belongs to the

Deciduous Forest Formation

The constitution of this formation on the rocks depends upon the historic development of the flora which in all probability occupied the ground when the surrounding country was covered with a forest similar to that which now exists farther north in the Catskill and Adirondack mountains. So that the facies, as it exists here along the Delaware River, is a fragment or remnant of a more extensive forest which exists in a climate somewhat colder than that of the Bucks County of to-day. The tree and associated vegetation of the talus slopes is as follows (FIGURES 2, 3, 4, and 5):

---

* Lyman, Benjamin Smith. Report on the New Red of Bucks and Montgomery counties. Summary description of the geology of Pennsylvania. Final report Geological Survey of Penna. 3: 2589–2638. 1895.

TALUS VEGETATION

FACIES SPECIES : *Fagus americana* (*F. grandifolia*), *Acer Saccharum*, *Betula lenta.*

DOMINANT SPECIES : *Tilia americana*, *Ulmus americana*, *Quercus Prinus*, *Ulmus racemosa*, *Fraxinus americana*, *F. pubescens* (*F. pennsylvanica*), *Acer rubrum*, *Carpinus caroliniana*, *Ostrya virginiana*, *Juglans cinerea*, *J. nigra.*

UNCOMMON SPECIES : *Acer nigrum* (*A. Saccharum*, var. *nigrum*), *Morus rubra*, *Celtis occidentalis*, *Robinia Pseudo-acacia.*

GREGARIOUS SPECIES : *Tsuga canadensis*, *Juniperus virginiana.*

RARE SPECIES : *Betula nigra*, *Liriodendron Tulipifera.*

VERY RARE TREES : *Castanea dentata*, *Platanus occidentalis.* The absence of the white oak, *Quercus alba*, and the almost entire absence of the chestnut, *Castanea dentata*, and the tulip tree, *Liriodendron Tulipifera*, are noteworthy. The facies, consisting of beech, sugar maple, and cherry birch, suggests a similar one in the Catskill and Adirondack mountains, which I have denominated elsewhere * the beech-maple-birch facies.

SECONDARY TREE SPECIES (underwood): The secondary species of the talus are those which can grow under the leafy canopy of the dominant trees of the forest. Such are *Acer pennsylvanicum*, *Prunus americana*, *P. virginiana*, *P. serotina*, *Hamamelis virginiana*, and *Rhododendron maximum*, which occurs in association thickets.

SHRUBBY UNDERGROWTH (third layer = Niederwuchs): The species are arranged in the order of their prevalence, as follows : *Taxus canadensis*, *Hydrangea arborescens*, *Acer spicatum*, *Staphylea trifolia*, *Physocarpus opulifolius*, *Diervilla trifida* (*D. Lonicera*), *Viburnum acerifolium*, *Cornus circinata*, *C. paniculata*, *Rubus odoratus*, *R. occidentalis*, and *Sambucus racemosa.* The yew forms extensive matted growths on the rough talus slopes and is one of the most abundant of the plants which are found as an undergrowth in the forest. It occurs also on the upper cliff slopes near the crest. Here and there along the road at the edge of the forest are colonies of the staghorn sumach, *Rhus typhina.* It is hardly to be included as a component of the natural vegetation of the talus slope. The woody vines, or lianes, which form a part of the Deciduous Forest Formation may be enumerated in the order of their importance.

---

* Harshberger, John W. The plant formations of the Adirondack Mountains, Torreya 5 : 187–194. 1905. The plant formations of the Catskills, The Plant World 8 : 276–281. 1905.

LIANES: *Ampelopis quinquefolia*, *Rhus radicans*, *Vitis Labrusca*, *V. aestivalis*, *V. cordifolia*, *V. vulpina*, *Celastrus scandens*, *Clematis virginiana*, *Menispermum canadense*, *Lonicera grata* (*L. Caprifolium*). Some of these ascend the rock faces, others reach the light by climbing the forest trees.

TREE MOSSES: The following mosses and hepatics, according to Lydia P. Borden, occur on the trunks and projecting roots of the forest trees. Near the base are found *Geocalyx graveolens*, *Lophocolea heterophylla*, *Dicranella heteromalla*, *Bryum roseum*, and, elsewhere, *Frullania eboracensis*, *Anomodon apiculatus*, *A. rostratus*, and *A. attenuatus*.

The forest floor is occupied by herbaceous plants which are commonly associated with the broad-leaved forest trees throughout the Piedmont Region. But it should be remarked here, that the numerical preponderance of certain of these herbs is to be accounted for by the peculiar habitat surroundings, as well as by the composition of the characteristic tree facies.

HERBACEOUS SPECIES (fourth, or ground layer): The classification of the herbaceous species of the forest is a difficult matter for several methods might be adopted according to the viewpoint of the observer. The following groups are adopted to arrange the herbs in the formation under consideration:

ABUNDANT FERNS: *Dryopteris marginalis*, *Polystichum acrostichoides*, *Adiantum pedatum*. Each of these ferns forms clumps on the forest floor. The first two species remain green during winter, while *Adiantum pedatum* is destroyed with the first sharp frost.

ROCK FERNS: *Polypodium vulgare* (abundant), *Cystopteris bulbifera* (not common), *Camptosorus rhizophyllus* (frequent on rock faces), *Asplenium Trichomanes*.

COMMON FERNS: *Asplenium ebeneum* (*A. platyneuron*), *Phegopteris hexagonoptera*, *Dennstaedtia punctilobula*, *Lycopodium clavatum*, *L. complanatum*, *Botrychium obliquum*, *B. virginianum*.

ABUNDANT HERBS: *Laportea canadensis*, *Impatiens fulva* (*I. biflora*), *Polygonatum biflorum*, *P. giganteum* (*P. commutatum*), *Smilacina racemosa*, *Asarum canadense*, *Mitella diphylla*, *Sangui-*

naria canadensis, *Aquilegia canadensis* (on the talus and on rocks), *Geranium Robertianum*, *Viola canadensis*, *Cimicifuga racemosa.*

SECONDARY HERBS: *Trillium erectum*, *T. cernuum*, *Thalictrum purpurascens*, *T. dioicum*, *T. polygamum*, *Hydrophyllum canadense*, *H. virginicum*, *Eupatorium ageratoides* (*E. urticaefolium*), *Parietaria pennsylvanica*, *Aralia racemosa*, *A. trifolia*, *Osmorrhiza brevistylis*, *Zizia cordata*, *Thaspium aureum*, *Cryptotaenia canadensis*, *Viola striata*, *V. blanda*, *V. cucullata*, *V. palmata*, *Galium Aparine*, *G. triflorum*, *Helianthus decapetalus*, *Aster cordifolius*, *Cerastium arvense* var. *oblongifolium*, *Actaea alba.*

WINTERGREEN SPECIES: On October 23, 1908, the writer observed the following species of the talus slopes which are the most important elements of the wintergreen flora: *Taxus canadensis*, *Asarum canadense*, *Geranium Robertianum* (in flower), *Carex platyphylla*, *Saxifraga pennsylvanica*, *Dryopteris marginalis*, *Polystichum acrostichoides*, *Polypodium vulgare*, *Tsuga canadensis*, and *Rhododendron maximum*, which the writer has shown elsewhere takes advantage of every mild, sunny day during the winter to manufacture starch and other organic products.

TALUS AND CLIFF ROCK MOSSES: The mosses and hepatics that grow on the talus and cliff rocks are: (Hepaticae), *Conocephalum conicum*, *Marchantia polymorpha*, *Pellia epiphylla*, *Geocalyx graveolens*, *Lophocolea heterophylla*, *Plagiochila asplenioides*, *Porella platyphylla*, *Scapania nemorosa;* and (Musci) *Catharinea angustata*, *C. undulata*, *Pogonatum brevicaule*, *Polytrichum commune*, *Webera sessilis*, *Fissidens osmundioides*, *F. bryoides* (wet and damp places), *Ceratodon purpureus*, *Dicranella heteromalla*, *D. h. Fitzgeraldi*, *D. scoparium*, *Ditrichum tortile*, *D. pallidum*, *Leucobryum glaucum*, *Weisia viridula*, *Funaria hygrometrica*, *Aulacomnium heterostichum*, *Bartramia pomiformis*, *Bryum argenteum*, *B. caespiticium*, *B. roseum*, *Mnium affine*, *M. punctatum*, *M. rostratum*, *M. sylvaticum*, *Anomodon apiculatus*, *A. rostratus*, *A. attenuatus*, *Thuidium delicatulum*, *Cirriphyllum Boscii*, *Hylocomium proliferum*, *H. triquetrum*, *Climacium americanum*, and *C. dendroides.*

The following list of additional plants arranged by families was furnished me by Dr. S. P. Seese, of Lansdale, Pennsylvania. All of them grow on the talus slopes of the Nockamixon Rocks.

Arisaema triphyllum,
“ *Dracontium*,
Medeola virginiana,
Erythronium americanum,
Oakesia sessilifolia,
Uvularia perfoliata,
Allium tricoccum,
Liparis liliifolia (rare),
Orchis spectabilis,
Habenaria lacera,
Cypripedium pubescens,
Aristolochia Serpentaria,
Claytonia virginica,
Anemone nemorosa,
Hepatica triloba,
Anemonella thalictroides,
Hydrastis canadensis (now extinct),
Podophyllum peltatum,
Caulophyllum thalictroides,
Dicentra Cucullaria,
“ *canadensis* (present years ago),
Corydalis glauca,
“ *aurea*,
Dentaria laciniata,
“ *diphylla*,
Arabis laevigata,
“ *perfoliata* (*A. glabra*),
canadensis,
Gillenia trifoliata,
Vicia americana,
Amphicarpa monoica,
Epilobium coloratum,
Circaea lutetiana,
Sanicula marilandica,
Thaspium barbinode,
Pyrola rotundifolia,
Monotropa uniflora,
Gentiana quinquefolia,
Obolaria virginica,
Asclepias tuberosa,
“ *purpurascens*,
“ *phytolaccoides*,
Polemonium coeruleum (*P. Van Bruntiae*),
Cynoglossum officinale,
Mertensia virginica,
Myosotis palustris (*M. scorpioides*),
Lophanthus nepetoides,
Teucrium canadense,
Scutellaria lateriflora,
“ *pilosa*,
Pentstemon laevigatus var. *digitalis*,
Pedicularis canadensis
Epiphegus virginiana
Veronica virginica,
“ *scutellata*,
“ *officinalis*,
“ *serpyllifolia*,
“ *peregrina*,
Triosteum perfoliatum,
Mitchella repens,
Galium circaezans,
Campanula americana,
Lobelia spicata,
“ *inflata*,
Aster oblongifolius,
“ *Novae-Angliae*,
“ *laevis*,
“ *vimineus*,
Erigeron bellidifolius (*E. pulchellus*),
“ *philadelphicus*,
Eupatorium purpureum,
Helianthus decapetalus,
Solidago speciosa,
“ *nemoralis*.

RAVINE VEGETATION

The trees and shrubs which extend into the ravines are essentially broad-leaved species which form a constituent part of the

Deciduous Forest Formation. The composition of the vegetation of the ravines is somewhat different from that of the talus slope, indeed, the dominant trees found in the glens are so associated as to form a distinct facies of the formation. As the flora of the ravines differs somewhat in each case, it will be considered with reference to the particular gully in which it occurs. The most characteristic ravine is one which cuts back into the middle portion of the cliffs. A stream cascades over precipitous rocks covered with mosses and liverworts, among them *Marchantia polymorpha*. The tree vegetation is as follows:

FACIES: *Tilia americana*, *Ulmus americana*.

DOMINANT ASSOCIATED SPECIES: *Quercus Prinus*, *Acer Saccharum*, *Ostrya virginiana*.

SHRUBBY UNDERGROWTH (Niederwuchs): *Taxus canadensis* (covering slopes extensively), *Hydrangea arborescens*, *Physocarpus opulifolius*, *Rubus odoratus*, *Celastrus scandens*.

HERBS OF FOREST FLOOR: The soil of the ravine slopes is utilized in the growth of *Asarum canadense*, *Impatiens fulva* (*I. biflora*), *Chelone glabra*, *Solidago flexicaulis* (*S. latifolia*), *Eupatorium ageratoides* (*E. urticaefolium*).

ROCK HERBS: The characteristic rock flora of these ravines includes *Aquilegia canadensis*, *Campanula rotundifolia*, *Arabis lyrata*, *Geranium Robertianum*, *Heuchera americana*, *Cerastium arvense* var. *oblongifolium*, *Saxifraga pennsylvanica*, *Lonicera grata* (*L. Caprifolium*), *Agrostis scabra* (*A. hyemalis*), *Polypodium vulgare*, *Camptosorus rhizophyllus*, *Celastrus scandens*, *Salix cordata*, *Physocarpus opulifolius*.

The most western ravine is filled with such an association of trees that a new facies may be said to exist.

FACIES: *Acer Saccharum*, *Fagus americana*, *Tsuga canadensis*. These trees comprise the maple-beach-hemlock facies.

ASSOCIATED TREES: Here grow in association such dominant trees as *Tilia americana*, *Betula lenta*, *Quercus Prinus*, *Morus rubra*, and *Acer rubrum*. The hemlock, *Tsuga canadensis*, is not sufficiently abundant to constitute a formation, but it is mixed with the broad-leaved trees in such proportion as to necessitate its inclusion in the deciduous forest proper. Associated with these trees as an *undergrowth* are found *Taxus canadensis* (abundant), *Hydran-*

gea arborescens, *Rhododendron maximum* (in thickets), *Viburnum acerifolium*, and the Virginia creeper, *Ampelopsis quinquefolia*.

SHADE HERBS: The herbs that grow in the dense shade are *Pilea pumila*, *Laportea canadensis*, *Hepatica triloba*, *Thalictum purpurascens* (*T. revolutum*), *Mitella diphylla*, *Smilacina racemosa*, *Maianthemum canadense*, *Impatiens fulva* (*I. biflora*), and *Adiantum pedatum*, which occupies the outcropping rock masses. As this ravine is ascended, the woods become drier and the hill slopes more gradual and the ravine vegetation fuses with that of the crest.

The valley back of the Narrowsville Hotel is characterized by a stream the flat banks of which show the presence of *Juglans cinerea*, *Fraxinus americana*, *Carpinus caroliniana*, *Betula lenta*, *Tilia americana*, *Liriodendron Tulipifera* (sparingly), and such shrubs as *Amelanchier canadensis*, *Lindera Benzoin* (*Benzoin aestivale*), *Hydrangea arborescens*, and *Rubus occidentalis*. On the slopes above a small waterfall are assembled *Dryopteris marginalis*, *Polystichum acrostichoides*, *Asarum canadense*, *Aquilegia canadensis*, *Impatiens fulva* (*I. biflora*), while on the steep rocks overhanging the stream are found the walking fern, *Camptosorus rhizophyllus* and the columbine, *Aquilegia canadensis*.

In the bottom of another ravine, the forest consists of such trees as *Acer Saccharum*, *Fagus americana* (*F. grandifolia*), *Quercus coccinea*, and, sparingly, *Liriodendron Tulipifera*. The shrubs are *Hamamelis virginiana*, *Corylus americana*, *Hydrangea arborescens*, *Rubus odoratus*, *Lindera Benzoin* (*Benzoin aestivalis*), *Sambucus racemosa*, and *Viburnum acerifolium*. The yew, *Taxus canadensis*, forms extensive masses, as elsewhere on the cliffs, while the marginal shield fern occurs in extensive patches. The forest floor is occupied by a covering of quite a few characteristic herbaceous plants, such as *Sanguinaria canadensis*, *Smilacina racemosa*, *Arisaema triphyllum*, *Asarum virginicum*, *Adiantum pedatum*, *Botrychium virginianum*, and on the rocks dripping with water occur the moss *Eurynchium hians* and the liverwort *Marchantia polymorpha*. Lower down, where the stream breaks over a rock face about 15 feet high, the ravine narrows and the hemlock, *Tsuga canadensis*, becomes more abundant, associated with *Betula lenta* and *Acer Saccharum* to form a facies (the maple-birch-hemlock facies), including *Quercus rubra*, *Rhododendron maximum*, *Corylus americana*, *Hy-*

drangea arborescens, *Acer spicatum*, *Taxus canadensis*, and the jewel weed, *Impatiens fulva*, together with the ferns, *Polystichum acrostichoides* and *Polypodium vulgare*, which adorn the tops of the projecting slate rocks. *Ampelopsis quinquefolia* drapes the mossy rocks of the ravine. The distribution of the mosses on the rocks is determined by the places where in midsummer the last water is found, in small trickling streams affording sufficient moisture to keep the mosses alive, while the rock-faces, where the stream, when full, falls over the slopes, are practically without any mossy covering.

RAVINE ROCK MOSSES : The mosses and hepatics found on the rocks of the ravines, according to Lydia P. Borden, are : (Hepaticae) *Marchantia polymorpha*, *Conocephalum conicum*, *Pellia epiphylla*, *Metzgeria conjugata*, *Cephalozia curvifolia*, *Lophocolea heterophylla*, *Geocalyx graveolens*, *Odontoschisma prostratum*, *Scapania nemorosa*, *Plagiochila porelloides*, *P. asplenioides*, *Porella platyphylla ;* and (Musci), *Catharinea undulata*, *Fissidens bryoides*, *Dicranella heteromalla*, *Funaria hygrometrica*, *Aulacomnium palustre*, *Philonotis fontana* (wet rocks), *Bryum argenteum*, *B. roseum*, *B. caespiticium*, *Mnium sylvaticum*, *M. punctatum*, *Anomodon apiculatus*, *A. rostratus*, *A. attenuatus*, *Thuidium delicatulum*, *Climacium americanum*, *C. dendroides*, *Cirriphyllum Boscii*, and *Plagiothecium denticulatum*.

In addition to the species mentioned in the above description, the ravine flora includes, according to Dr. S. P. Seese, of Lansdale, Pennsylvania :

Osmunda regalis,
“ *cinnamomea*,
Asplenium Filix-foemina,
Dryopteris noveboracensis,
“ *spinulosa*,
“ *spinulosa* var. *intermedia*,
“ *simulata*,
Corallorhiza odontorhiza,
Goodyera pubescens,
Adlumia cirrhosa (*A. fungosa*),
Cercis canadensis,
Cornus alternifolia,
Kalmia latifolia,
“ *angustifolia*,
Senecio obovatus,
Nabalus altissimus.

SUMMIT-SLOPE AND CLIFF-CREST VEGETATION

Ascending the hills back of the Narrowsville Hotel, the botanist encounters a forest which covers the slopes up to the crest of the hill. Here the woods consist of such trees as *Quercus Prinus*, *Q. coccinea*, *Q. rubra*, *Q. alba* (rare), *Fagus americana* (*F. grandifolia*), *Tsuga canadensis*, *Acer rubrum*, *Betula lenta*, *Carya porcina* (*Hicoria glabra*), *Hamamelis virginiana*, and *Viburnum dentatum*, and in dry rocky situations a facies is formed of red cedar, *Juniperus virginiana*. The woody vines of these woods are *Ampelopsis quinquefolia*, *Rhus radicans*, *Vitis Labrusca*, and *Celastrus scandens*. *Ceanothus americanus*, the New Jersey tea, forms pure associations in open places well lighted by the sun.

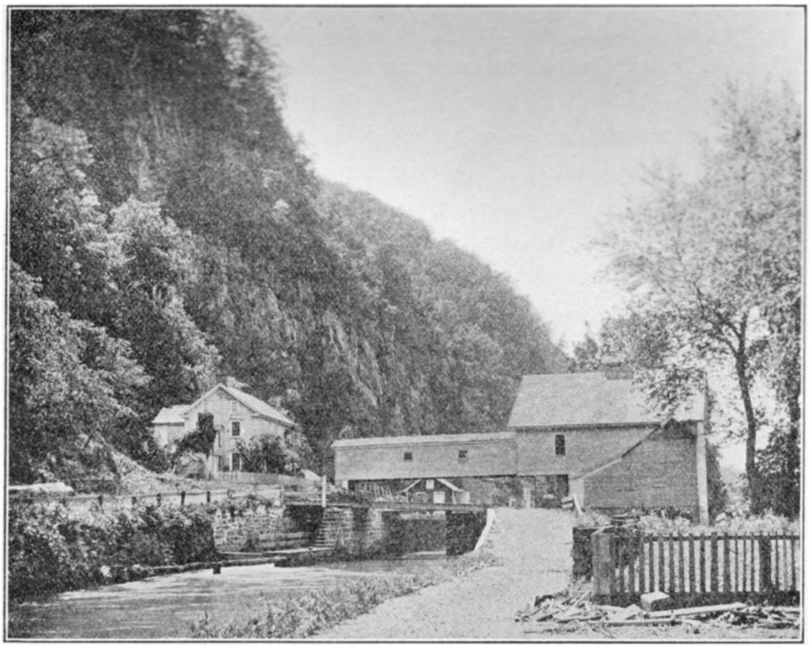

FIGURE 3. Talus slopes, precipitous rocks, and summit slopes showing the Deciduous Forest Formation.

Reaching the head of a large ravine, the character of the woods changes somewhat, merging into the cliff-crest vegetation. Prominent in this transition forest are *Quercus Prinus*, *Castanea dentata* (the only place where the chestnut is prominent), *Quercus rubra*, *Acer Saccharum*, and as secondary species, *Hamamelis virginiana*, *Viburnum acerifolium*, and the herb *Cunila Mariana* (*C. origanoides*). This is a forest growth which connects the facies of the talus slope with the tree growth and other vegetation, which typically covers the crest slopes above the precipitous rocks below. All along the cliffs just back of the crest slope are cultivated fields where the gullies cut back into the tableland, so that the crest flora forms a narrow fringe which is continuous with the slopes that gradually dip to the precipices below. The soil of these slopes (FIGURES 3 and 5) is edaphically dry and the tree vegetation is conditioned largely by the character of the underlying substratum.

FACIES: The steeper slopes where the crest flora is most typically developed are occupied by *Quercus Prinus* (the most abundant tree), *Ulmus americana*, *Ostrya virginiana*, *Acer Saccharum*, *Quercus rubra*, *Rhododendron maximum* (on the steepest slopes).

The rocks which jut out beyond the general crest (FIGURE 5) and from which the escarpment falls abruptly to the river below are tenanted by such trees as *Quercus rubra*, *Q. tinctoria* (*Q. velutina*), *Q. Prinus*, *Ostrya virginiana*, *Betula lenta*, *Cornus florida*, and at the extreme edge are found wind-tossed forms of the red cedar, *Juniperus virginiana*. Perhaps such vegetation should be included as a part of the Rock-Cliff Formation, later to be described. Before considering that formation it should be mentioned that at one point the soil of the tableland is too barren for profitable cultivation of agricultural crops, although the attempt was made years ago to till these barren fields. The abandoned fields are grown up to *Pinus rigida* and *Juniperus virginiana*, dotted over in an open formation (park-like); associated with *Ceanothus americanus* and *Rhus typhina*, together with various weeds.

DOMINANT TREE SPECIES: *Tilia americana*, *Acer rubrum*, *Carya alba* (*Hicoria ovata*), *Nyssa sylvatica*, *Sassafras officinalis*, *Prunus serotina*, *Fraxinus americana*, *Castanea dentata* (rare), *Pinus Strobus* (rare), and *Populus grandidentata*.

SECONDARY UNDERGROWTH SPECIES: The brinks of the precipices (FIGURE 3) show masses of the yew, *Taxus canadensis*, together with *Diervilla trifida* (*D. Lonicera*), *Gaylusaccia frondosa*, *G. resinosa* (*G. baccata*), *Ribes rubrum*, *R. rotundifolium*, *Physocarpus opulifolius*, and *Lonicera grata* (*L. Caprifolium*). In addition the crest is occupied by *Amelanchier canadensis*, *Hamamelis virginiana*, *Staphylea trifolia*, *Viburnum dentatum*, *V. pubescens*, and *Celastrus scandens*.

LIANES: The trees are festooned with such vines as *Vitis cordifolia*, *V. Labrusca*, *Clematis virginiana*, *Smilax rotundifolia*, and *Menispermum canadense*.

HERBACEOUS CREST SPECIES: The ground under the above-mentioned trees and shrubs is covered by *Impatiens fulva* (*I. biflora*), *Smilacina racemosa*, *Arisaema triphyllum*, and *Sedum Telephium* (*S. purpureum*), which retains its green color as late as November, and in addition the botanist finds the plants in the list below.

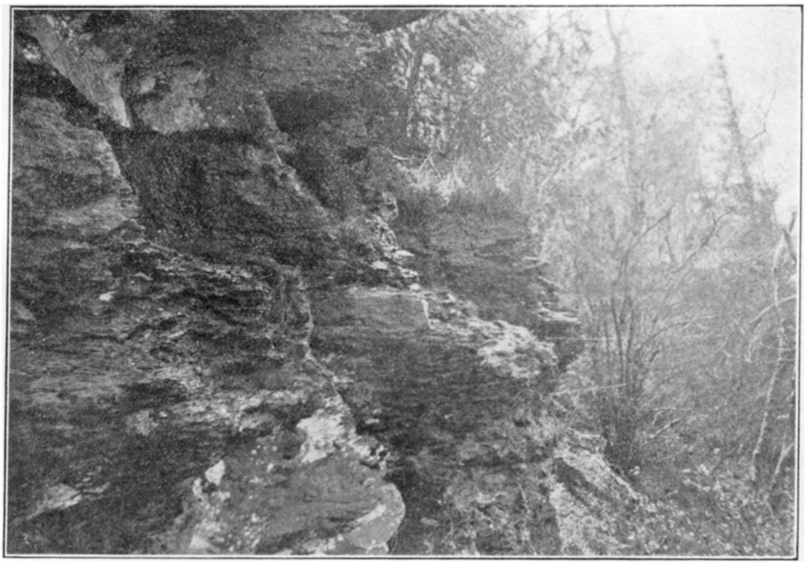

FIGURE 4. Details of Rock Cliff Plant Formation with the Deciduous Forest Formation to the right, covering the talus slopes.

CREST ROCK MOSSES: According to Lydia P. Borden, the crest rocks are characterized by *Catharinea angustata*, *Polytrichum commune*, *P. piliferum*, *Leucobryum glaucum*, *Weisia viridula*, *Funaria hygrometrica*, *Bryum roseum*, *Mnium sylvaticum*, *Cirriphyllum Boscii*, *Climacium americanum*, and *C. dendroides*.

LIST OF ADDITIONAL CREST HERBS (furnished by Dr. S. P. Seese)

Selaginella rupestris,
Smilax herbacea,
Lilium philadelphicum,
Hypoxis erecta,
Spiranthes gracilis,
" *cernua*,

Comandra umbellata,
Polygonum tenue,
Silene stellata,
Anemone virginiana,
Arabis canadensis,
Spiraea salicifolia,
Fragaria virginiana,
“ *vesca,*
Apios tuberosa,
Baptisia tinctoria,
Tephrosia virginiana,
Oxalis violacea,
“ *stricta,*
Linum virginianum,
Polygala sanguinea,
“ *verticillata,*
Acalypha virginica,
Hypericum ellipticum,
Lechea major (L. villosa),
“ *minor,*
Viola sagittata,
“ *pubescens,*
“ *fimbriatula,*
“ *scabriuscula,*
Cuphea viscosissima (C. petiolata),
Ipomoea Quamoclit,
“ *pandurata,*
Pimpinella Saxifraga,
Lithospermum arvense,
Trichostema dichotomum,
Cunila Mariana (C. origanoides),
Pycnanthemum lanceolatum,
Hedeoma pulegioides,
Monarda fistulosa,
“ *punctata,*
Gerardia flava,
Melampyrum americanum,
Sicyos angulatus,
Aster corymbosus (A. divaricatus),
Aster macrophyllus,
“ *patens,*
“ *cordifolius,*
“ *sagittifolius,*
“ *multiflorus,*
“ *prenanthoides,*
Eupatorium ageratoides (E. urticaefolium),
Helianthus divaricatus,
“ *strumosus,*
Hieracium canadense,
“ *paniculatum,*
“ *scabrum,*
“ *venosum,*
Sericocarpus conyzoides (S. asteroides),
Solidago bicolor,
“ *caesia,*
“ *latifolia,*
“ *rugosa.*

The following additional species, not allocated to any of the various habitats previously mentioned, are characteristic of the dry woods, Nockamixon Rocks, according to Dr. Seese, who has botanized here over forty years:

Anychia dichotoma (A. polygonoides),
Geum album
“ *virginianum,*
Agrimonia Eupatoria (A. gryposepala),
“ *parviflora,*
Desmodium nudiflorum,
Desmodium acuminatum (D. grandiflorum),
“ *canescens,*
“ *viridiflorum,*
Lespedeza procumbens,
“ *capitata,*
“ *Nuttallii,*
“ *violacea.*

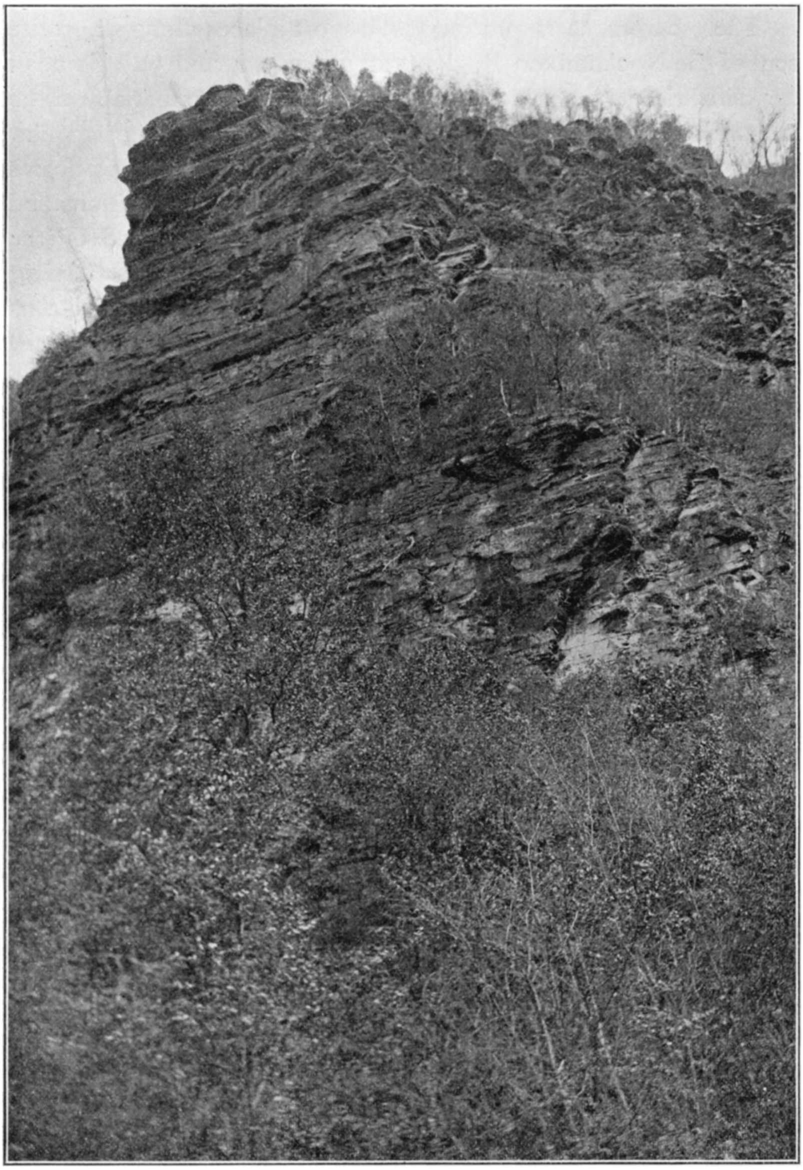

FIGURE 5. Top Rock, Delaware Narrows, showing Deciduous Forest Formation of the talus slopes, the Rock-cliff Plant Formation and the xerophytic deciduous forest covering the almost bare rocks of the summit.

Rock-cliff Formation

The escarpment is precipitous in most places along the entire front of the Nockamixon Rocks (FIGURES 2, 3, 4, and 5). Some of the cliffs rise as a sheer wall for a distance of 300 feet above the country road at their base. The face of the precipice is irregular owing to the numerous clefts, pockets and shelves, or platforms which are found at various elevations and in various positions and exposures (FIGURES 4 and 5). The pockets are formed by the falling of masses of rock. The shelves are flat ledges running along the face of the precipice (FIGURE 5). One such shelf runs at least two thousand feet in an upward sloping direction toward the west. In places, it is ten feet wide, in other places it narrows down to a width of one or two feet. The smaller ledges are occupied by grasses and other herbaceous plants, while the larger projecting flats accommodate various trees, shrubs, and lianes which climb up the vertical rock surfaces.

VEGETATION OF LARGER ROCK SHELVES : The vegetation of the long shelf just mentioned consists of such trees as *Ostrya virginiana*, *Celtis occidentalis*, *Ulmus americana*, *Acer Saccharum*, *Juniperus virginiana* (abundant), *Juglans cinerea*, *Quercus rubra*, *Prunus virginiana*, *Hamamelis virginiana*, *Tilia americana*, and *Prunus serotina*, while the most characteristic shrub is *Physocarpus opulifolius*. Other shrubs are associated with the trees and the nine-bark, viz., *Rubus occidentalis* (in sunny exposures), *Rubus odoratus*, *Taxus canadensis* (in dense masses), *Staphylea trifolia*, *Sambucus racemosa*, and on small rock shelves, *Lonicera grata* (*L. Caprifolium*). In the shade of the trees grow clumps of *Dryopteris marginalis*, *Impatiens fulva* (*I. biflora*), *Smilacina racemosa*, *Hepatica triloba*, and *Aquilegia canadensis*. The unshaded rock exposures are characterized by *Pentstemon hirsutus* (*P. pubescens*), *Heuchera americana*, *Achillea Millefolium*, *Linaria vulgaris*, *Verbascum Thapsus*, *Cerastium arvense* var. *oblongifolium*, *Aquilegia canadensis*, *Geranium Robertianum*, *Saxifraga virginiensis*, and *Nepeta Cataria*.

West of the main outlook, the rocks present a series of easily descended, serially arranged shelves (FIGURE 5), each occupied by an association of plants. *Phlox subulata* grows in masses on the bare shale rock, while the broad rock shelves here are occupied by *Amelanchier canadensis*, *Rubus canadensis*, *R. hispidus*, *R. strigosus*, *Rhus typhina*, *Fraxinus pubescens*, *Populus grandidentata* (rare), *Betula lenta*, *Ostrya virginiana*, *Aster cordifolius*, *Baptisia tinctoria*, and *Sedum Telephium* (*S. purpureum*). The lianes begin their growth on a shelf, or in a rock pocket and ascend the cliffs, as if directed on a trellis. Such are *Ampelopsis quinquefolia*, *Vitis cordifolia*, and *Rhus radicans*. Near the top of the cliffs on some shelves (FIGURE 5) sheltered by the overhanging rocks and associated with *Campanula rotundifolia*, *Anemone pennsylvanica*, *Chelone glabra*, *Steironema ciliatum*, *Salix cordata*, *Physocarpus opulifolius*, *Maianthemum canadense*, *Polypodium vulgare*, and *Geranium Robertianum*, grows the most unique plant of the Nockamixon Rocks, viz., *Sedum Rhodiola* (*S. roseum*). This plant, which grows on the bare shale rock, is anchored by thick, succulent, coral-like, branching rhizomes, which give rise in summer to the grayish green leaves and small yellowish green flowers. Each season the leaves fall from the plant, and the bare rhizomes, with the additional annual growth, perennate until the next growing season. The writer measured one plant with a rhizome six inches long and with roots that penetrated the rock crevices over two feet. This plant is perhaps most abundant beneath the shelving rocks at the head of one of the ravines, which is kept cool by the currents of air which strike the rocks in such a direction as to be deflected into the rocky amphitheater at the head of the glen, where the roseroot grows so abundantly. On several hot days last summer, the temperature was perceptibly lower in the shadow of the beetling cliffs, fanned by the breezes, which blew into the glen from the north. In all probability, *Sedum Rhodiola* (*S. roseum*) is a relict of the time when the climate was much colder than now — a time characterized by the retreat of the glacial ice sheets that covered the headwaters of the Delaware River. The present distribution of the plant supports this view, because it occurs in Greenland and Labrador, on the high alpine peaks from Alberta and Alaska to Colorado and California (altitude 9,000–14,000 feet), also along the coast to rocky islands and cliffs in eastern Maine * and locally at Chittenango Falls, New York, on the high cliff off Port Jervis, Wayne County, Pennsylvania, and the

---

* Cushman, Joseph A. Some interesting Maine plants. Rhodora 11 : 12. 1909.

Nockamixon Rocks, Pennsylvania. Its preservation on the Nockamixon cliffs is probably due to two factors, viz., the coolness of the habitat under the rocks at the head of the glen with a northern exposure and the isolation or inaccessibility of the shelves upon which the plant grows.

VEGETATION OF THE SMALLER ROCK SHELVES : The vegetation of the smaller rock shelves varies (FIGURE 4). One shelf is occupied by *Cerastium arvense* var. *oblongifolium*, another by *Geranium Robertianum*, another is fringed with a grass, *Muhlenbergia tenuiflora* (*M. Willdenowii*). Still other shelves are characterized by *Poa debilis*, *Oryzopsis melanocarpa* (*O. racemosa*), *Anemone virginiana*, *Potentilla canadensis*, *Heuchera americana*, *Saxifraga virginiensis*, *Galium boreale*, *Solidago caesia*, while *Physocarpus opulifolius* and *Juniperus virginiana* are found occasionally on the cliff face in rock pockets.*

PLANTS OF THE CREVICES AND ROCK POCKETS : The characteristic plants of the rock crevices and smallest rock depressions (FIGURE 4), apparently growing out of the precipice itself, are: *Dryopteris marginalis*, *Asplenium Trichomanes*, *Polypodium vulgare*, *Cystopteris fragilis*, *Woodsia ilvensis*, *W. obtusa*, *Aquilegia canadensis*, *Cerastium arvense* var. *oblongifolium*, *Arabis lyrata*, *A. laevigata*, *Geranium Robertianum*, *Heuchera americana*, *Verbascum Thapsus*, and *Campanula rotundifolia*. The species seize every vantage ground and it is surprising to find how their roots can penetrate and hold fast to a narrow crack, or fissure, in the face ot the smooth rock faces.

WEED VEGETATION

NATIVE MIGRANTS : The native plants which have left their original habitats and have spread along the roadside form an element of the vegetation which illustrates what species have adapted themselves to the new environmental conditions. The species of composite plants owe their spread to the light fruits which are wind-distributed.

---

*The writer wishes to state with reference to the identification of the plants mentioned in this and other of his phyto-geographic papers that the following plan is pursued. If he feels no doubt as to the identity of the plant, it is noted in the field notebook ; if he is in doubt, a specimen is collected, tagged, and identified at field headquarters by means of some manual · and, if unable after such study to name the plant, a specimen is dried for more careful study with herbarium material at hand.

Cystopteris fragilis,
Tradescantia virginiana,
Commelina nudiflora (*C. communis*),
Euphorbia maculata,
“ *Preslii*,
“ *hirsuta*,
Crotalaria sagittalis,
Cassia marilandica,
“ *Chamaecrista*,
“ *nictitans*,
Lysimachia quadrifolia,
“ *Nummularia*,
Castilleja coccinea,
Nepeta Glechoma (*N. hederacea*),
Leonurus Cardiaca,
Lamium maculatum,
Aster multiflorus,
“ *dumosus*,
Eclipta alba,
Helenium autumnale,
Mikania scandens,
Solidago lanceolata (*S. graminifolia*),

INVADING WEED SPECIES: The original formations have been disturbed but little by the invasion of weed species, because the original vegetation has remained in possession of the rocks and talus slopes and, therefore, the formations are closed ones in the phytogeographic sense. The following species of foreign introduction are elements which might strongly alter the existing formations, if not held in check by the native vegetation. However, it is important to recognize this element and enumerate the species belonging to it. The species in small capitals were introduced by the early Pennsylvania German settlers, who cultivated them.

Urtica dioica,
HUMULUS LUPULUS
Rumex crispus,
“ *obtusifolius*,
“ *Acetosella*,
Polygonum orientale,
“ *Persicaria*,
FAGOPYRUM ESCULENTUM,
Chenopodium album,
“ *Botrys*,
Amaranthus retroflexus,
Phytolacca decandra,
Mollugo verticillata,
Dianthus Armeria,
“ BARBATUS (established for years),
Saponaria officinalis,
Lychnis vespertina (*L. alba*),
Agrostemma Githago,
Stellaria media,
Cerastium vulgatum,
Portulaca oleracea,
Ranunculus bulbosus,
Helleborus niger (escaped),
Sisymbrium officinale,
Brassica nigra,
Capsella Bursa-pastoris,
Lepidium campestre,
Potentilla norvegica,
Trifolium arvense,
“ PRATENSE,
“ REPENS,
“ *procumbens*,
“ *agrarium*,
“ INCARNATUM,
Melilotus alba,
“ *officinalis*,
Medicago sativa,
LINUM USITATISSIMUM,
Malva rotundifolia,

Malva sylvestris,
Sida spinosa,
Hibiscus Trionum,
Abutilon Avicennae (*A. Theophrasti*),
Hypericum perforatum,
Daucus Carota,
PASTINACA SATIVA,
FOENICULUM OFFICINALE,
Echium vulgare,
Brunella vulgaris,
Lamium amplexicaule,
“ *maculatum*,
Nepeta Cataria,
“ *Glechoma* (*N. hederacea*),
MENTHA ROTUNDIFOLIA,
“ *viridis* (*M. spicata*),
“ *piperita*,
Verbena urticifolia,
“ *hastata*,
Solanum Dulcamara,
Datura Stramonium,
Convolvulus arvensis,
Plantago lanceolata,
Valerianella olitoria (*V. Locusta*),
Dipsacus sylvestris,
Achillea Millefolium,
Anthemis Cotula,
“ *arvensis*,
Arctium Lappa,
ARTEMISIA ABSINTHIUM (pretty well established),
Cirsium lanceolatum,
“ *arvense*,
Chrysanthemum Leucanthemum,
“ *Parthenium* (established),
Galinsoga parviflora,
TANACETUM VULGARE,
Taraxacum officinale.[*]

HISTORIC SKETCH

The Nockamixon Rocks have been visited by a number of local botanists, who have spent a day or two in the study of its interesting flora. Nothing has been published on this flora except a short note by E. Newlin Williams, entitled “Botanizing in the Delaware Narrows” which appeared in Meehan's Monthly, March, 1897, pages 43 and 44. The flora of the Rocks was first carefully studied by Professor Thomas C. Porter of Lafayette College, Easton, Pa. He was followed by Professor J. T. Rothrock, Dr. S. P. Seese, Dr. J. Bernard Brinton, Mr. Stewardson Brown, Dr. C. D. Fretz, who notes some of the Nockamixon plants in his “Flora of Bucks County,” and by Dr. N. L. Britton. The Torrey Botanical Club and the Philadelphia Botanical Club made a joint excursion to the place on May 30, 1893, under the leadership of Professor Thomas C. Porter. The Botanical Society of Pennsylvania botanized here on Decoration Day, May 30, 1908, under the guidance of Dr. Samuel P. Seese of Lansdale, Pa. The writer has made three successive trips to the Narrows, viz., on May, 30, 1908, June 30, 1908 and October 23, 1908, several days being spent during June and early July in the collection of plants and in a study of the flora. Collections of Nockamixon plants repose in the herbaria of Lafayette College, Easton, Pennsylvania, of the Academy of Natural Sciences of Philadelphia, of the New York Botanical Garden, and of the University of Pennsylvania.

---

[*] Dr. S. P. Seese, of Lansdale, Pennsylvania, is authority for this list.

UNIVERSITY OF PENNSYLVANIA,
PHILADELPHIA, PA.